THE WEATHER AND CIRCULATION OF MAY 1962

Record Heat in the Mid-West

JAMES F. O'CONNOR

Extended Forecast Branch, U.S. Weather Bureau, Washington, D.C

1. INTRODUCTION

Summer seemed to come about a month early to States east of the Rockies in May 1962 as temperatures soared to values much more characteristic of June, producing the hottest May on record over a large part of this region. By contrast, the West was unseasonably cool, especially later in the month.

The rainfall pattern also exhibited marked contrasts, notably between the Northern Plains, where the wettest May on record occurred in many places, and the South, where a severe drought set new records for consecutive days without rain.

The heat in central and eastern sections was in sharp contrast to the cool weather a year ago [1]. While that May was notable for persistence of an earlier cold regime, May this year showed remarkably little persistence from April. Only 34 percent of the country failed to change more than one temperature class (out of 5), in comparison with the 1942–1957 average of 62 percent for April to May changes [2].

This marked reversal in temperature was also duplicated in the precipitation regime. For example most areas of heavy April precipitation this year [3] in the South, East, and Northeast, had relatively light amounts in May, while the West and North Central States, which had been relatively dry in April, received sharply increased rainfall, ranging to three times the normal in some areas. This was especially beneficial in the Northern Plains, but in the Southern Plains moisture remained critically short in some areas, expecially in Texas.

2. THE PLANETARY CIRCULATION

The average circulation at 700 mb. in May 1962 was one of considerable amplitude at middle latitudes, with deeper than normal troughs in the western United States and off the east coast, and strong ridges in the eastern Pacific and eastern United States (fig. 1). (May 1959 had a strikingly similar circulation and temperature pattern, but with major differences in precipitation to be discussed later).

At high latitudes the pattern was flatter than usual due to lower than normal heights in the Yukon ridge and above normal heights over the Bering Sea and eastern Canada. This represented a dramatic reversal from April in the western sector of the hemisphere, as ridges replaced troughs and vice versa.

This reversal and its amplification over North America was apparently the result of a long antecedent trend evident as far back as early April in the Pacific. At that time a vigorous shearing of the mid-Pacific trough occurred associated with strong height rises southeast of Kamchatka (fig. 2A). This trend evolved, in late April, into a strong blocking High in the north-central Pacific as the middle and low latitude wave trains became completely out of phase (fig. 2B).

During early May, continued progression at higher latitudes, relative to the stationary lower-latitude waves, resulted in reamalgamation of the Bering Sea ridge with the eastern Pacific subtropical ridge (fig. 2C). Corresponding realignment of the downstream troughs produced a full-latitude trough along the west coast of North America in the manner described by Namias [5]. This was followed by amplification over the United States in the last half of May (fig. 2D) as the shearing trend between high and low latitudes again resumed.

3. SYNOPTIC ACTIVITY

The very slow movement of the deepening planetary trough in the Far West during May resulted in rather persistent weather over many areas. However, significant short-period variability occurred, principally near the zone of strong temperature contrast extending from the central Rockies to the upper Mississippi Valley. This was also the region of principal surface cyclone activity, with maximum frequency occurring in South Dakota where the most abnormal rains occurred. Conditions were also relatively changeable near the east coast due to periodic "back-door" cold air intrusions which were favored by strong northerly anomalous components of the average flow at 700 mb. (fig. 1).

Early in the month, the only High to emerge from the Rockies during May crossed the South and became stationary in the Southeast. It was preceded by showers over much of the East and by the last rains to occur in many parts of the South and Southeast until the end of the month. West of this High to the Pacific coast, a warming trend developed with temperatures rising to 20° F. above normal in Iowa on the 5th.

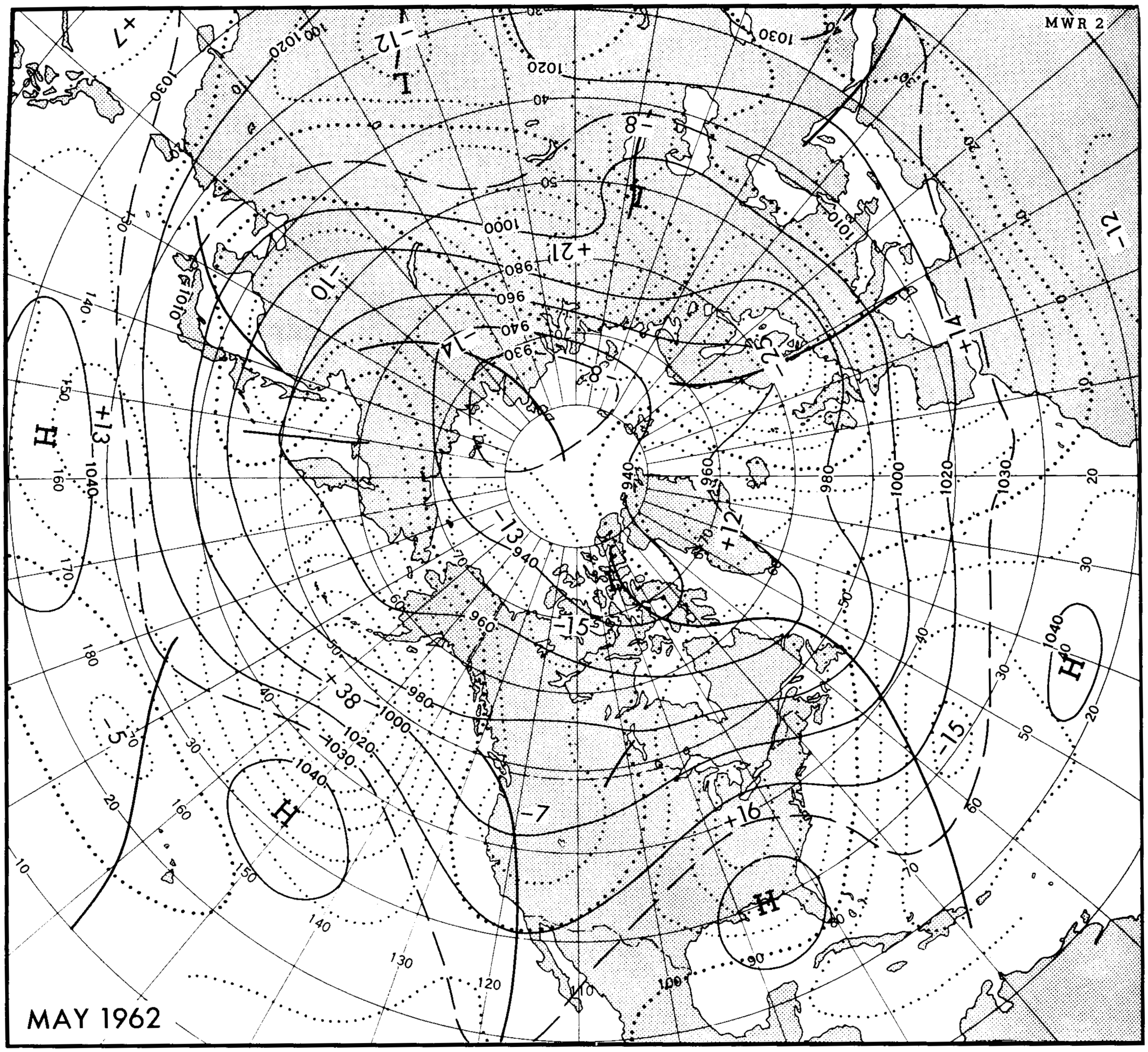

FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet for May 1962. Strong ridge in eastern Pacific maintained amplified wave pattern over the United States.

From the 6th to the 10th two successive Highs crossed southern Canada and the Great Lakes north of a front which became stationary near 40° N. Precipitation was widespread in the north due to overrunning of the cooler air which ranged to 14° F. below normal in the Northern Plains. The southern half of the country was mostly dry and persistently hot with temperatures up to 20° F. above normal in Kansas and Nebraska.

From the 10th to mid-month the deep planetary trough aloft near the Pacific coast moved inland, producing cool showery conditions in the Far West. Temperatures fell to 15° F. below normal in Nevada, while the hot air spread to the east coast although the warmest, 24° F. above normal, occurred in Michigan on the 15th. Rain again occurred primarily in northern sections, due to disturbances along a very strong front near the Continental Divide.

The only major change from the 16th to the 20th was cooling in the Upper Mississippi Valley from as much as 32° F. above normal on the 17th to slightly below normal three days later. Also notable was the excessive rainfall on the 19th at St. Joseph, Mo., where over 5 inches fell in a 2-hour period during a thundershower.

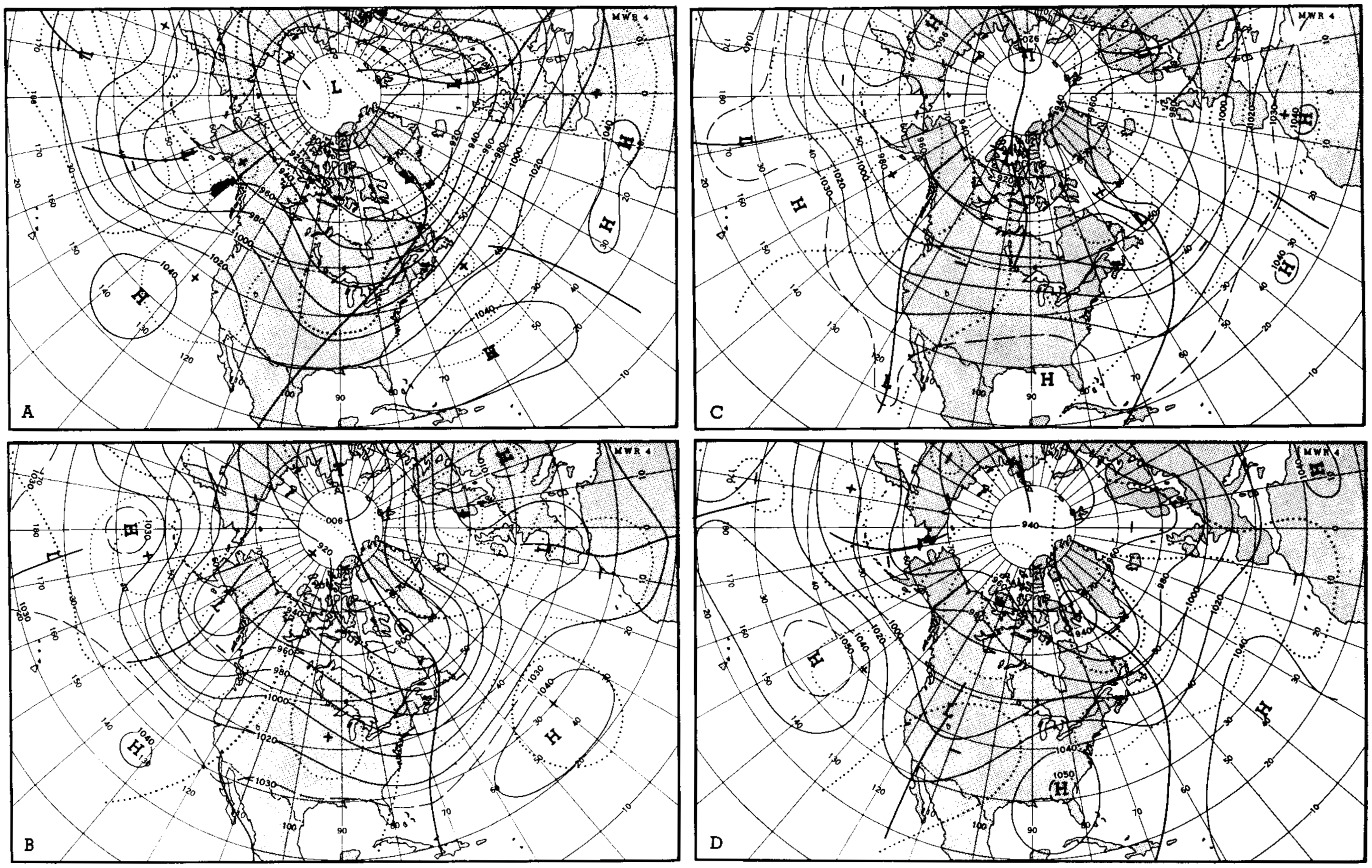

Figure 2.—Average half-month contours (solid) (tens of feet) and 15-day height changes from preceding period (dashed) (at 200 ft. interval, zero line heavy) for (A) early April, (B) late April, (C) early May, and (D) late May 1962. Evolution shows shearing and reamalgamation in Pacific followed by amplification over North America.

From the 21st to the 25th the deepest storm of the month spread more heavy precipitation from the central Rockies to the Upper Mississippi Valley, maintaining relatively cool conditions north of its trailing front which was located along 40° N. on the 25th. However the coolest air still remained in the Far West, primarily over Nevada, while the warmest temperatures were in the South.

Late in the month cooler air, ranging to 17° F. below normal, invaded the North Central States as the strong planetary ridge aloft in the East weakened, permitting the first shower activity since the beginning of the month to traverse the deep South and thus ending the month-long drought. The associated cloudiness also helped to alleviate the extreme heat which had prevailed in the South since early May.

4. TEMPERATURE

With temperatures in the "much above normal" category over most of the United States east of the Continental Divide, this was the hottest May on record in a large part of that region. Many sections registered average monthly temperatures close to the normal June values, and some were even warmer, notably Birmingham and Mobile, Ala., Thomasville, Ga., Wichita, Kans., and Greenville, S.C. Figure 3 shows the observed distribution of the monthly average departures from normal. The hottest area relative to normal was centered near Kansas City, Mo., which reported an average maximum temperature of 85.2° F. Another hot spot was Birmingham, Ala., where the maxima averaged 92.3° F. or 0.1° F. warmer than Yuma, Ariz., which had daily maxima of 100° F. or over from the 2d to the 10th. Many cities reported this May to be the warmest on record. Some of these are listed in table 1.

Table 1.—*Cities reporting May 1962 the warmest on record*

	Mean temp. (°F.)	°F. above normal
Birmingham, Ala.	78.6	8.3
Mobile, Ala.	80.1	6.0
Macon, Ga.	78.2	4.3
Thomasville, Ga.	79.2	3.8
Cairo, Ill.	77.1	8.1
Evansville, Ind.	74.4	9.1
Concordia, Kans.	71.6	8.0
Dodge City, Kans.	71.1	7.4
Topeka, Kans.	72.7	8.3
Wichita, Kans.	75.4	9.4
Lexington, Ky.	71.6	7.1
Muskegon, Mich.	61.2	6.4
Springfield, Mo.	72.3	7.8
Kansas City, Mo.	74.7	9.6
St. Joseph, Mo.	72.7	8.6
Greenville, S.C.	76.5	5.8
Chattanooga, Tenn.	75.2	6.6
Knoxville, Tenn.	74.0	5.8
Memphis, Tenn.	76.8	6.0
Nashville, Tenn.	75.2	6.6

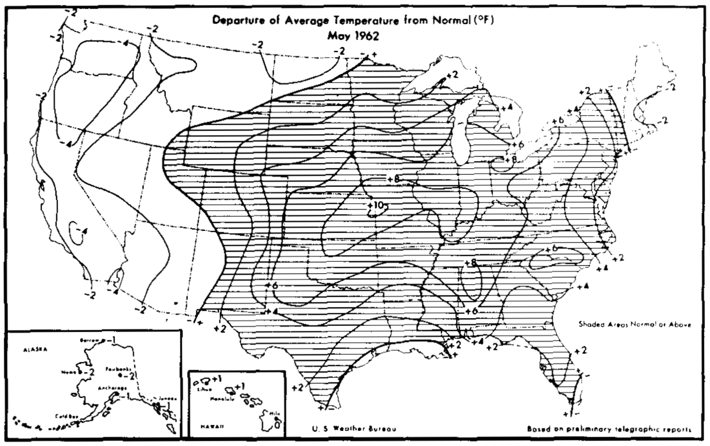

FIGURE 3.—Mean temperature departures from normal (°F.) for May 1962. (From [6].) Temperatures were more characteristic of June than May east of the Rockies.

Among the cities which had their second warmest May on record were Little Rock, Ark.; Pensacola, Fla.; Indianapolis, Ind.; Detroit, Mich.; Burlington, Des Moines, and Sioux City, Iowa; St. Louis, Mo.; Lincoln and Omaha, Nebr.; Dayton, Sandusky, Toledo, and Youngstown, Ohio; Oklahoma City, Okla.; Florence, S.C.; and Dallas, Tex.

Many of the above also reported new records for number of days with maxima of 90° F. or above, generally far surpassing the previous records. Notable among those were Birmingham with 24 days, Memphis 19, Cairo 16, Wichita 13, Richmond 11, Greensboro 10, Kansas City 9, Cincinnati 8, and Detroit 6.

In the western United States, on the other hand, the coolness did not establish new records generally, although some sections in the Pacific Northwest did have their coolest May on record (Salem, Oreg.) or second coolest (Yakima, Wash.).

Figure 4 shows the slow eastward progress of the heat wave which was centered in the Central Plains in the first part of the month (fig. 4A) and in the middle Mississippi Valley in the latter part (fig. 4B). The cool spell in the West was centered in the Pacific Northwest in the first half-month, migrating southward and eastward in the latter half.

The warmth in the central part of the country was closely related to the amplified circulation pattern for the month. That is, the strong positive height departures centered over the Ohio Valley, together with the strong southerly anomalous flow over central sections favored unusually warm temperatures. In addition, extreme dryness in the South and the associated parched ground surface intensified the heat-source characteristics of the region, both locally as well as farther north. The diminution of the warmth north of about 40° N. and east of the Appalachians reflected not only the more frequent intrusions of cooler air masses but also the associated cloudiness as the cooler air was overrun by the warmer air from the South.

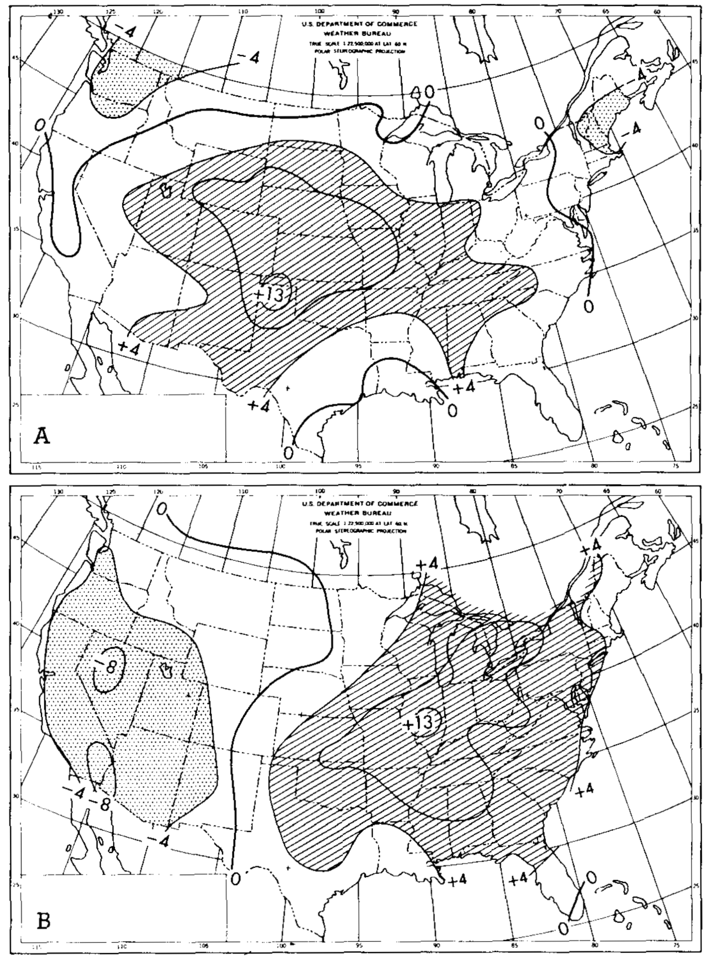

FIGURE 4.—Half-month mean temperature departures from normal (°F.) for (A) early May (B) late May 1962. Heat wave maximum drifted slowly from the Plains to the Mississippi Valley.

In the West the temperature regime reflected the persistent cool cloudy and showery conditions associated with unstable air in the deep planetary trough which remained entrenched there during most of the month.

5. PRECIPITATION

The percentage of normal precipitation for May 1962 is shown in figure 5. Heavy amounts occurred from the Pacific Northwest to the Upper Mississippi Valley. Rainfall was especially heavy in the Northern Plains, notably in South Dakota with three times the normal amount, resulting in the wettest May on record in some areas. Some of the record amounts reported were: 8.01 in. at North Platte, Nebr.; 11.5 in. at St. Joseph, Mo.; 4.80 in. at Fargo, N. Dak.; and 9.21 in. at Rapid City, S. Dak.

Abnormally large to record numbers of thunderstorm days occurred throughout the heavy rain belt, and ten or more days with thunderstorms were common from the Northern Plains across the Mississippi Valley to the Ohio Valley. One of the most notable sections was near Sioux City, Iowa, where thunderstorms on 17 days and

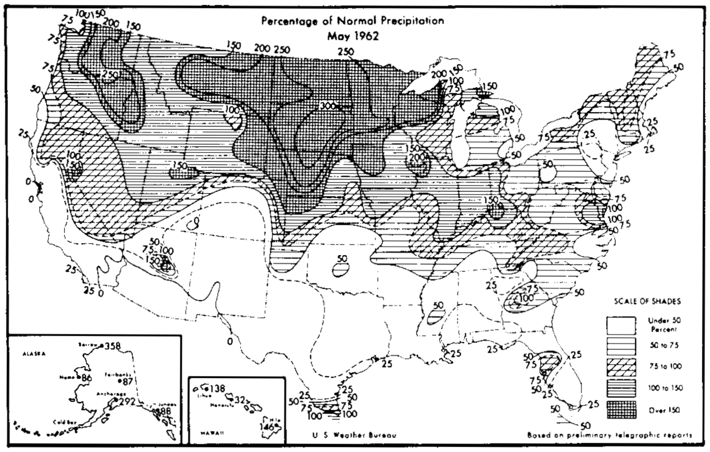

Figure 5.—Percentage of normal precipitation for May 1962. (From [6].) Most notable features are heavy rains in the Plains and drought in the South.

hail on 5 days were the most recorded in any month since records began in 1890.

Excessive short-duration rains were also common, some notable ones being the 7.12 in. in 24 hr. on the 18th and 19th at St. Joseph, Mo., and 4.6 in. at Dubuque, Iowa on the 28th and 29th. Farther to the east Reading, Pa. received 3.27 in. in 2 hr. on the 31st.

In the South, a dry spell of record duration occurred in many places lasting 3 to 4 weeks. The drought ended in Texas and Louisana on the 28th with rains of 3 to 4 in. in some localities, and general showers fell throughout the Gulf States and Southeast on the last 3 days of the month. After no measurable rain at Birmingham, Ala., since May 1, the 1.21 in. which fell from the 29th to 31st was referred to as "The Million Dollar Rain" in that region.

In relation to the average circulation (fig. 1) it appears that the heavy precipitation in the North Central States was associated with stronger than normal southerly flow, while the dryness in the East and Southeast was favored by the abnormally strong northerly flow east of the planetary ridge. The abnormal dryness in the Southern Plains can be explained, however, only by a very subtle characteristic of the circulation there; viz., the slightly above normal heights in northwestern Mexico which resulted in a more westerly flow than usual favoring drier air in Texas and New Mexico. This is to some extent reflected in the lowest average humidity on record reported at El Paso, Tex.

Turning now to the major differences in precipitation between this May and May of 1959 which had a strikingly similar circulation anomaly pattern (compare fig. 1 with fig. 6A), it may be of some value to examine the subtle characteristics which distinguished the two circulations, as reflected by the height differences (fig. 6B). By contrast with this month, May 1959 had heavy rain in the Southeast and in the Southern Plains, and drier conditions in the western Dakotas (fig. 6C). In view of the small

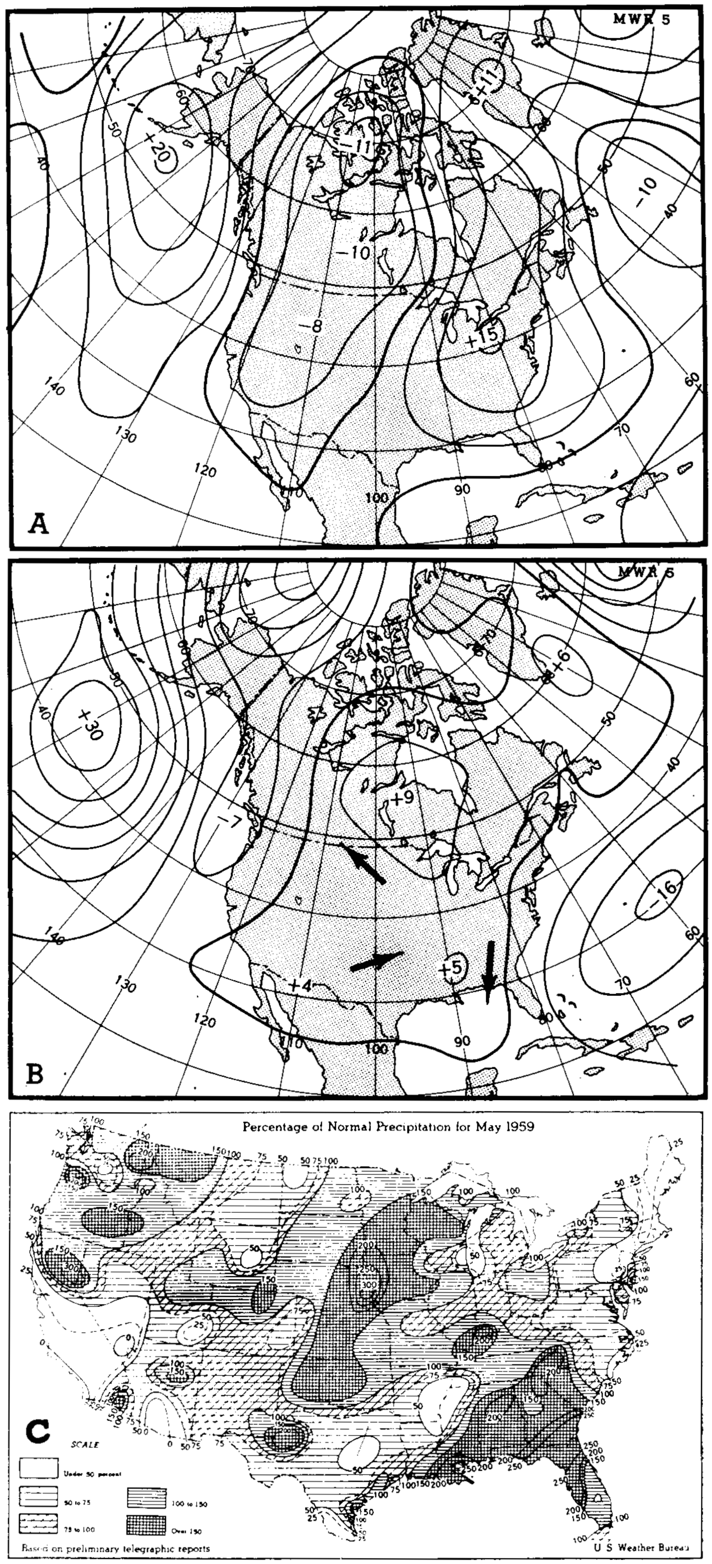

Figure 6.—(A) Height departures from normal for May 1959 (tens of feet, zero line heavy). (B) Height differences (May 1962 minus May 1959) (tens of feet, zero line heavy). Arrows show that the May 1962 circulation was more northerly in the Southeast, more westerly in the Southern Plains and more southeasterly in the Northern Plains than that of May 1959 in agreement with the differences in precipitation regimes. (C) Percentage of normal precipitation May 1959. (From [6].)

height differences (fig. 6B) over North America, the distinction between the two cases is highlighted by the arrows in figure 6B, which are quantitative in direction only. These show that the May 1962 circulation was more northerly in the southeastern United States and hence drier than in 1959, and more westerly in the Southern Plains, also a drier influence due to the drier source and the downslope motion. In the Northern Plains the flow this May was more southeasterly and hence wetter than in 1959, probably because of the greater upslope components over the cooler air to the northwest. with some additional orographic lifting. The more southeasterly nature of this month's flow correspondingly influenced the tracks of cyclones and vorticity maxima emanating from the Rockies, also favoring heavy precipitation farther to the northwest (western Dakotas). By the same token, lessening of the heavy precipitation to the west of the Continental Divide in the northern Rockies this May can be attributed to the downslope influence of anomalous easterly flow components.

REFERENCES

1. R. H. Gelhard, "The Weather and Circulation of May 1961—Persistent Cool Weather in the United States," *Monthly Weather Review*, vol. 89, No. 8, Aug. 1961, pp. 299–305.
2. J. Namias, "Persistence of Mid-Tropospheric Circulation between Adjacent Months and Seasons," *The Rossby Memorial Volume*, The Rockefeller Press in association with Oxford University Press, New York, 1959, pp. 240–248.
3. C. M. Woffinden, "The Weather and Circulation of April 1962—A Month with Persistent Blocking in the Pacific," *Monthly Weather Review*, vol. 90, No. 7, July 1962, pp. 299–305.
4. C. M. Woffinden, "The Weather and Circulation of May 1959—Including an Analysis of Precipitation in Relation to Vertical Motion," *Monthly Weather Review*, vol. 87, No. 5, May 1959, pp. 196–205.
5. J. Namias, "Thirty-Day Forecasting—A Review of a Ten-Year Experiment," *Meteorological Monograph*, vol. 2, No. 6, American Meteorological Society, July 1953. (See pp. 61–62.)
6. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. XLIX, No. 23, June 4, 1962, and vol. XLVI, No. 23, June 1959.

CORRESPONDENCE

(Continued from p. 350)

frequency end of the spectrum is far from satisfactory owing to errors in transosonde positioning.

As an explanation for the small magnitude of inertial oscillations, Mantis and Huch [4] have hypothesized the existence of small-scale pressure gradients which are undetectable on the synoptic scale. The possible influence of the vertical advection of velocity is noted from the fact that inertial oscillations are time dependent and hence, if the wind speed varies with height, the wavelengths of the inertial oscillations will vary with height and the undulations will not line up in the vertical. The frictional interplay resulting from vertical motions could then have a large damping effect upon the horizontal oscillations at a given level.

REFERENCES

1. C. W. Newton, "Axial Velocity Streaks in the Jet Stream: Ageostrophic 'Inertial' Oscillations," *Journal of Meteorology*, vol. 16, No. 6, Dec. 1959, pp. 638–645.
2. J. S. Sawyer, "Quasi-Periodic Wind Variations with Height in the Lower Stratosphere," *Quarterly Journal of the Royal Meteorological Society*, vol. 87, No. 371, Jan. 1961, pp. 24–33.
3. J. K. Angell, "Use of Constant Level Balloons in Meteorology," *Advances in Geophysics*, vol. 8, Academic Press Inc., New York, 1961.
4. H. T. Mantis and W. F. Huch, "Meteorological Studies Using Constant Altitude Balloons," *Technical Report* No. AP–14, School of Physics, University of Minnesota, 1959, 63 pp.

U.S. GOVERNMENT PRINTING OFFICE: 1962